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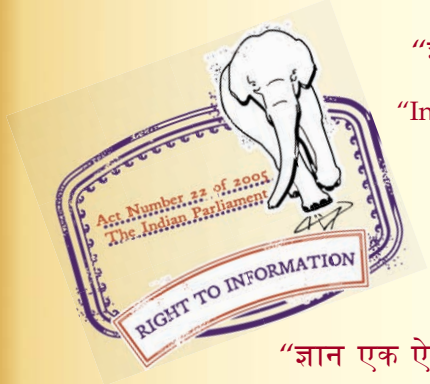
IS 2212 (1991): Code of practice for brickworks [CED 13: Building Construction Practices including Painting, Varnishing and Allied Finishing]



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"Knowledge is such a treasure which cannot be stolen"

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IS 2212 : 1991
(Reaffirmed 2005)

भारतीय मानक

ईंट निर्माण कार्य — आचार संहिता

(पहला पुनरीक्षण)

Indian Standard

BRICK WORKS—CODE OF PRACTICE

(First Revision)

First Reprint OCTOBER 1998
UDC 693·22·006·76

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

October 1991

Price Group 9

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Building Construction Practices Sectional Committee had been approved by the Civil Engineering Division Council.

This standard was first published in 1962. In this revision types of bricks mentioned in the Table 1 have been modified to bring it in line with IS 1077 : 1991 'Common burnt clay building bricks (*fifth revision*)', Further the materials to be used for mortar have been modified on the basis of IS 2250 : 1981 'Code of practice for preparation and use of masonry mortars (*first revision*)'.

Figures showing a typical arrangement of cut-brick in a corner has been modified to show the normal practice adopted by Central Public Works Department and other organizations.

The provisions of this standard do not limit its application to cases where only modular bricks are used; on the other hand, they can be applied with equal advantage to traditional bricks constructions as well as special size brick constructions. It is considered that this unified approach in the standard will be particularly advantageous during the period of transition from traditional brick construction to modular brick construction resulting in significant saving in bricks, mortar and labour.

It may be noted that the requirements bearing directly on the dimensions of bricks have been so worded as to be applicable both to modular and traditional bricks. For example, when the requirements for thickness of wall is stated as 'one brick' this will mean 20 cm nominal thickness in case of modular brick and 9 inch nominal thickness in the case of traditional brick of size 9 in × 4½ in × 3 in.

This standard is intended chiefly to cover the technical provision relating to brickwork and it does not cover all the necessary provisions of a contract.

This standard is one of a series of Indian Standards codes of practice covering masonry. Other standards in the series cover stone masonry and concrete block masonry.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

BRICK WORKS — CODE OF PRACTICE

(First Revision)

1 SCOPE

1.1 This standard covers the construction of brick masonry in general and the erection of brick walls in particular.

1.2 Only masonry with clay bricks is dealt with in this standard. Use of unburnt bricks (*kachcha* bricks) and use of mud mortar are not specifically covered in this standard.

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjucts to this standard.

3 TERMINOLOGY

3.0 For the purpose of this code, the following definitions shall apply.

3.1 General

Beam Filling — The filling of the gap between the ceiling level and the wall bearing level excluding portions occupied by beams, rafters, etc.

Bond — The arrangement of the bricks in successive courses tie the brickwork together both longitudinally and transversely; the arrangement is usually designed to ensure that no vertical joint of one course is exactly over the one in the next course above or below it, and there is the greatest possible amount of lap.

Coping or Weathering — The cover applied over or the geometrical form given to a part of structure to enable it to shed rain-water.

Corbel — A cantilever projecting from the face of a wall to form a bearing.

Cornice — Horizontal ornamental feature projecting from the face of a wall.

Course — A layer of bricks including bed mortar.

Damp-proof Course — A layer of impervious material laid or inserted in a structure to arrest the permeation of dampness.

Efflorescence — A powdery encrustment of salts left by evaporation. This may be visible on the surface or may be below surface. In the latter case, this is termed as crypto-florescence.

Footings — A projecting course or courses formed at the base of a wall to spread the load.

Header — A brick laid with its length across the wall.

Indenting — The leaving of recesses into which future work can be bonded.

Jamb — The part of the wall at the side of an opening.

Joint — A junction of bricks.

Bed Joint — Horizontal joint in brickwork or masonry.

Cross Joint — A joint other than a bed point normal to the wall face.

Jointing — The operation of finishing joints as the masonry work proceeds (*see* also **6.5.2**).

Nominal Thickness of a Wall — This is the thickness of wall that is stated in the estimates for calculation of quantities. It is a 'fictitious' dimension, which is neither the actual thickness of wall excluding surface finishes like plaster, rendering, etc, nor necessarily the overall thickness including such finishes. The following example will illustrate this point:

	Nominal Thickness	*Actual Thickness*
For traditional brick of 9 in length (with allowance of $\frac{1}{2}$ in for mortar joint):		
One-brick wall	9 in	$8\frac{1}{2}$ to $8\frac{3}{4}$ in
$1\frac{1}{2}$-brick wall	13 $\frac{1}{2}$ in	13 to $13\frac{1}{4}$ in
2-brick wall	18 in	$17\frac{1}{2}$ to $17\frac{3}{4}$ in
For modular brick (with allowance of 1 cm for mortar joint):		
One-brick wall	20 cm	19 cm
$1\frac{1}{2}$-brick wall	30 cm	29 cm
2-brick wall	40 cm	39 cm

Parapet — A solid or pierced guard wall for flat terrace of a balcony (or a bridge) or a curb wall at the lower part of a pitched roof, which is exposed to atmosphere on face, back and top.

Perpend — An alignment of cross joints which can be checked with a plumb line.

Pointing — The operation of finishing joints subsequent to the completion of masonry (*see* also **6.5.3**).

Profile — A guide used for setting out brickwork accurately.

Quoin — An external corner in brickwork; the term may also denote the masonry unit based to form the quoin.

Racking Back — Stepping of the unfinished end of the wall masonry.

Reveal — The visible part of each side of a recess or opening of a wall.

Sleeper Wall — A dwarf wall usually honeycombed to carry a plate or sleeper supporting a joisted floor.

Squint — A brick of special shape used at an obligue quoin (*see* Fig. 1A).

Stretcher — A brick laid with its length in the direction of wall.

Toothing — Bricks left projecting in alternate courses to bond with future work.

3.2 Materials

Bat — Any portion of a brick, cut or broken across its length usually known according to its fraction from the whole size, for example, 1/2-bats, 3/4 bats, etc.

Closer — Part of a brick either manufactured or cut from a whole brick and used to maintain bond.

Bevelled Closer — Illustrated in Fig. 1B.

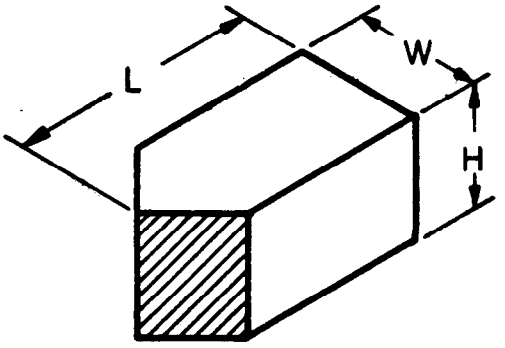
King Closer — Illustrated in Fig. 1C.

Queen Closer — Illustrated in Fig. 1 D.

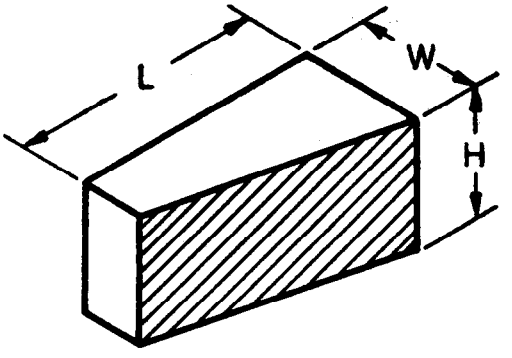
Facing Bricks — Bricks which, being exposed to view as in the case of unplastered surfaces, are required to have pleasing appearance, sufficient resistance to penetrations by rain and greater durability than common bricks.

Flashing — A sheet of impervious material fixed to a structure so as to cover an intersection or joint where water will otherwise leak through.

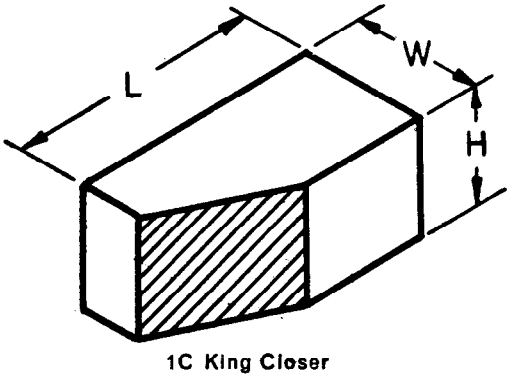
Templet — A pattern of sheet metal used as a guide for setting out specific section and shape.



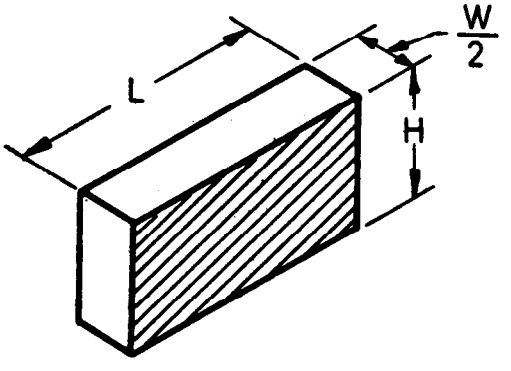
1A Squint



1B Bevelled Closer



1C King Closer



1D Queen Closer

L = Length of modular brick
W = Width of modular brick
H = Height of modular brick

FIG. 1 DIFFERENT TYPES OF PART-BRICKS

Template or Bed Block — A block of stone or concrete bedded on a wall to distribute the pressure from a concentrated load.

3.3 Tools and Accessories

3.3.1 Tools required for brick masonry work, such as plumb line, rules, straight edges, trowels, etc, are described in IS 1630 : 1984.

3.3.2 *Scaffolding and Staging*

These are temporary frame works commonly of bamboo, timber or tubular steel, having verticals, horizontals and diagonal braces secured or leashed together with nails, ropes or other types of fasteners, such as clamps. These are used for supporting ramps and working platforms from which the construction work at higher levels is carried out. Scaffoldings are of two types, namely, single and double scaffolding. Single scaffolding consists of a row of verticals connected to walls by horizontals supported on and tied to the structure. Double scaffolding consists of two rows of verticals secured or leashed together with horizontal and diagonal bracings, forming essentially a structure independent of the building. It may, however, be also connected to the structure at convenient points for the sake of better stability.

3.3.3 *Storey Rods*

These are battens of wood running one or more floor heights and having permanent markings corresponding to the location of brick courses at various heights and of all openings, sills, lintels, sun-shades and similar features occurring in the floors.

4 NECESSARY INFORMATION

4.1 For efficient planning, design and execution of the work, detailed information with regard to the following shall be furnished to those responsible for the work:

a) Layout plans showing the orientation of the structure;

b) Dimensioned details of the structure with details of sections (to a suitably large scale that is 1/20 or 1 cm = 20 cm), levels of foundations, finished ground levels, clear floor to floor heights of rooms, sizes of openings, etc.

c) Type and class of brickwork, types of bond and final finish for the brickwork; the mixes of mortar to be used, etc; full size details of architectural features, mouldings and other special work.

d) Location and other details of openings, chases, embedments of service lines, such as for water supply, drainage, electrical installations, etc; and location and details of hearths, flues and chimneys in the brickwork.

4.2 All information as in **4.1** shall be made available to those who are responsible for the masonry work. Necessary drawings and instructions for planning the work shall be furnished.

4.3 Arrangements shall also be made for the proper exchange of information between those engaged in masonry work and all those whose work will affect or will be affected.

5 MATERIALS

5.1 Bricks

5.1.1 Unless specified otherwise, burnt-clay bricks used shall conform to IS 1077 : 1991. Heavy duty brick as per IS 2180 : 1991 shall be used when the building is subjected to very heavy loading.

5.2 Mortars

Mortars for masonry shall be prepared in accordance with IS 2250 : 1981. The ingredients used in mortar shall conform to the requirements specified in **5.2.1** to **5.2.6**.

5.2.1 *Cement*

Cement used for brick masonry shall conform to IS 269 : 1976 or IS 455 : 1976 or IS 1489 : 1976 or IS 3466 : 1968 or IS 8041 : 1978 or IS 8043 : 1978.

5.2.2 *Lime*

Lime used for brick masonry shall conform to IS 712 : 1984.

NOTE — Hydraulic and semi-hydraulic limes corresponding to Class A, B and E of IS 712 : 1984 are conveniently available for use in masonry mortars, whereas fat limes, corresponding to Class C and D will require mixing of burnt clay pozzolana and other pozzolanic material, Class C and D limes may also be used with addition of cement and pozzolanic material. Quick lime shall never be used for structural purpose. It must be slacked first. Slacking at site shall be done in accordance with IS 1635 : 1975.

5.2.3 *Lime Pozzolana Mixture*

Lime pozzolana mixture used for brick masonry shall conform to IS 4098 : 1983.

5.2.4 *Pozzolana*

5.2.4.1 Calcined clay pozzolana shall conform to IS 1344 : 1981.

5.2.4.2 Fly ash shall conform to IS 3812 : 1981.

5.2.5 *Fine Aggregate*

Sand shall conform to IS 2116 : 1980.

5.2.6 *Water*

Water used for making masonry mortars shall be clean and free from injurious quantities of deleterious materials. Potable water is generally considered satisfactory for use in masonry mortar. For further requirements regarding limits of deleterious materials permitted in water, reference may be made to IS 456 : 1978.

5.3 Materials for Damp-proof Courses

Materials for damp-proof courses shall be specified to conform to one of the relevant Indian Standards or other requirements stated below:

a) Bituminous felts for waterproofing and damp-proofiing	Conforming to IS 1322 : 1982
b) Bituminons compounds for waterproofing purposes	Conforming to IS 1580 : 1969
c) Mortar or concrete for use in damp-proof course	Conforming to **6.8.1.1**
d) Stone slab for damp-proofing	Conforming to **6.8.1.2**

5.4 Materials for Flashing and Weathering

These shall be specified to conform to one of the relevant Indian Standards stated below:

a) *Lead Flashing*	Conforming to IS 405 (Part 2) : 1977 and the thickness shall be between 1·6 and 2 mm.
b) *Bituminous Felts*	Conforming to IS 1322 : 1982.

5.5 Metal Reinforcement

Metal reinforcement for use in brick masonry shall be specified to conform to one of the relevant Indian Standards stated below:

a) Mild steel or medium tensile steel bars	Conforming to IS 432 (Part 1 and 2) : 1982
b) Steel fabric or hard-drawn steel wire	Conforming to IS 1566 : 1982
c) Expanded metal	Conforming to IS 412 : 1975
d) Other suitable metal reinforcement, such as galvanized hoop iron	These shall be made of structural steel conforming to IS 226 : 1975

6 DESIGN CONSIDERATIONS

6.1 Selection of Bricks

6.1.1 For use in various situations of brick masonry, the brick shall be selected in accordance with Table 1.

6.1.2 When the requirements for strength of masonry predominate in the particular situation of use, the bricks shall be of such grade (*see* IS 1077 : 1991) as to give the required strength for masonry and shall be selected in accordance with their relevant provisions of IS 1905 : 1987.

6.2 Selection of Mortars

6.2.1 Mortars used for brick masonry shall conform generally to IS 2250 : 1981.

6.2.2 The selection of mortar will also be governed by the strength required for masonry and reference may be made in IS 1905 : 1987 for knowing the suitability of combination of various types of mortars and grades of bricks for different strengths required for the masonry.

6.3 Types of Bonds and Their Suitability

6.3.1 The primary object of bond is to give strength to masonry, but it may also be employed to create artistic effects when the brickwork is exposed to view.

The types of bonds generally in use, their characteristics and situations of use are described in Table 2.

6.3.2 In brickwork the cross joints in any course shall not be nearer than a quarter of brick length from those in the course below or above it.

6.4 Thickness of Joint

6.4.1 No bed joint shall be thicker than 12 mm. Further the thickness of the bed joints shall be such that four courses and three joints taken consecutively shall measure as follows:

a) In the case of traditional bricks	Equal to four times the actual thickness of the brick plus 3 cm
b) In the case of modular bricks conforming to IS 1077 : 1991	Equal to 39 cm

6.5 Finishing of Joints

6.5.1 The face joints of brickwork may be finished by 'jointing' or by 'pointing'.

Table 1 Selection of Building Bricks

(*Clause* 6.1.1)

Sl No.	Situation of Use	Type of Bricks to be Used	Special Consideration	Remarks
(1)	(2)	(3)	(4)	(5)
1.	Facing	Class 12·5 common bricks (*see* 1077 : 1991)	Bricks shall be free from minor defects, such as chips at the edge of corners. Colour and texture may also be specified if so required	—
2.	a) Subject to very heavy loading	Heavy duty (*see* IS 2180 : 1988)	—	—
	b) Requiring a high resistance to water penetration	do	—	—
3.	a) Plinths and foundations below damp-proof course — ground well drained and no chance of continual wetting in foundations	Class 12·5 or Class 7·5 common bricks (*see* IS 1077 : 1991)	—	—
	b) Plinths and foundations below damp-proof course — subsoil water table at a high level	do	The bricks shall be free from efflorescence. They shall also not have any salt content which will affect the mortar of the masonry. The bricks may preferably be the denest available with the minimum water absorption	
4.	a) External walls, neither plastered nor rendered on the outer face	Class 12·5 common bricks (*see* IS 1077 : 1991)	The bricks shall preferably be of uniform colour	The exposed joints shall be pointed with a dense water tight mortar
	b) External walls finished on both faces with a water-tight plaster or rendering	Class 7·5 or better quality common bricks (*see* IS 1077 : 1991)	—	For situations exposed to severe weather (*see* Table 3) only Class 12·5 common bricks shall be used as in 4(a).
5.	Internal walls	Class 7·5 common bricks (*see* IS 1077 : 1991)	—	Class 3·5 common bricks also may be considered for use, provided they satisfy the requirements for strength (*see* IS 1077 : 1991) For walls which are liable to be frequently in contact with water such as in bathrooms, only Class 7·5 or better bricks shall be used
6.	Free standing walls, parapets	Class 12·5 common bricks (*see* IS 1077 : 1991)		A dense water-tight mortar shall be used for the masonry. Parapets shall preferably be finished on all sides with a water-tight plaster

Table 2 Common Types of Bonds for Brickwork and Situations of Their Use

(*Clause* 6.3.1)

Sl No.	Types of Bond	Characteristics	Situation of Use	Remark
(1)	(2)	(3)	(4)	(5)
1.	English Bond	The bricks in the facing are laid in alternate courses of headers and stretchers (*see* Fig. 2). The header course is commenced with a quoin header followed by a queen closer and continued with successive headers. The stretcher course is formed of stretchers having a minimum tap of one-quarter their length over the header	The bond contributes substantially to the strength of brickwork, and may be particularly suitable for walls carrying heavy loads	Less efficient bonds may also be successfully used for obtaining strength provided the mortar is strong
2.	Double Flemish Bond	The courses both in the facing and in the backing are formed with alternating stretchers and headers. In order to obtain the lap (which is equal to one-quarter the length of the bricks) a queen closer is introduced next to the quoin header in alternate courses, the intervening ones commencing with a stretcher and every header will obtain a location that is central with respect to the stretcher above or below (*see* Fig. 3)	The appearance on the face may be considered as more uniform than in English bond. Requires less number of facing bricks than English bond and hence may be economical where brickwork is faced with special facing bricks and exposed to view	Though considered inferior in strength than English bond, this bond may be suitable for single-brick thick walls in normal house construction provided a strong mortar, such as cement mortar, is used
3.	Single Flemish Bond	This facilitates the facing of the wall to be in Flemish bond and the backing in English bond. This will entail use of snap headers (*see* Fig. 4)	This attempts to combine partially the better appearance of Flemish bond, with the better strength of English bond. However, increase in strength over Double Flemish bond is doubtful	—
4.	Garden Wall Bond	English garden wall bond (*see* Fig. 5) consists of a header course with the necessary queen closer next to quoin header to three or sometimes even five stretcher courses running in series with overlap of half-brick between stretcher over stretcher Flemish garden wall bond (*see* Fig. 6) consists of alternate courses composed of one header to three sometimes even five stretchers in series throughout the length of the courses	One-brick thick walls are easier to construct with these bonds than with pure Flemish or English bonds and save facing bricks considerably in the case of exposed work	—
5.	American Bond (also known as Common Bond)	Consists (*see* Fig. 7) of one header course to a number of stretcher courses	For general use	Commonly adopted in America. The number of stretcher courses may vary from five to seven

(*Continued*)

Table 2 (*Continued*)

Sl No.	Types of Bond	Characteristics	Situation of Use	Remarks
(1)	(2)	(3)	(4)	(5)
6.	Stretcher Bond	In this bond (*see* Fig. 8) all the courses are stretcher courses and the overlap is usually half brick and is obtained by commencing each alternate course with a half-bat With slight modification at the quoin the overlap may be varied to ¾ or ¼ brick and the bond is then known '*Raking Stretcher Bond*'	Used in ½-brick thick leaves of cavity walls	—
7.	Header Bond	The facing of this bond (*see* Fig. 9) has all the courses as headers only and the overlap, which is half the width of the brick is obtained by introducing a three-quarter bat in each alternate course at quoins	Used for walls curved on plan for better alignment; and preferably in foundation footings of brick masonry for better transverse distribution	

NOTES

1 Several other special bonds are also in vogue, such as Monk Bond, Dutch Bond, English Cross Bond and mixed bonds of various types which give different artistic effects so far as appearance is concerned.

2 The bonds described above have been developed largely as a result of the traditional 9 in × 4½ in × 3 in bricks, but all have been found to be suitable for modular bricks of size 20 cm × 10 cm × 10 cm. In the course of use of modular bricks more bonds may be evolved for giving improved functional characteristics to the masonry.

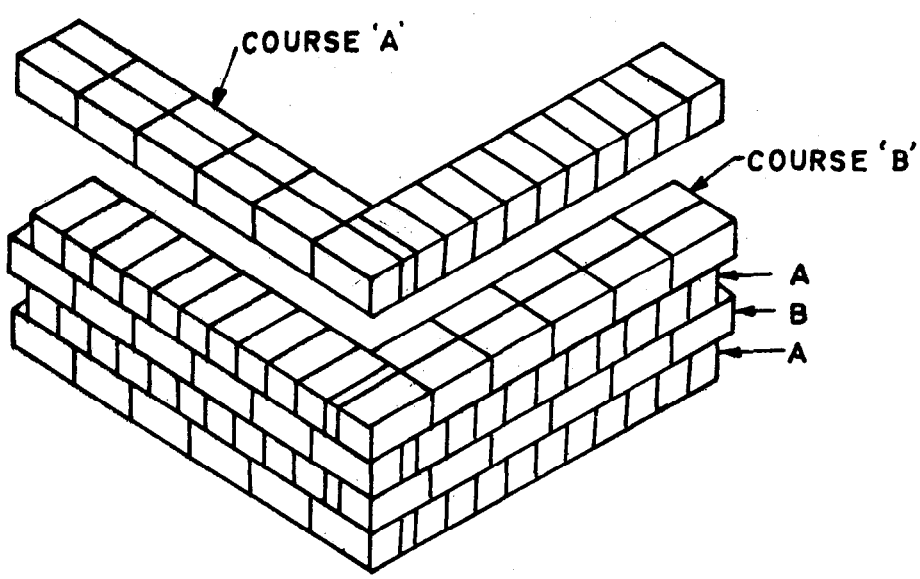


FIG. 2 ENGLISH BOND

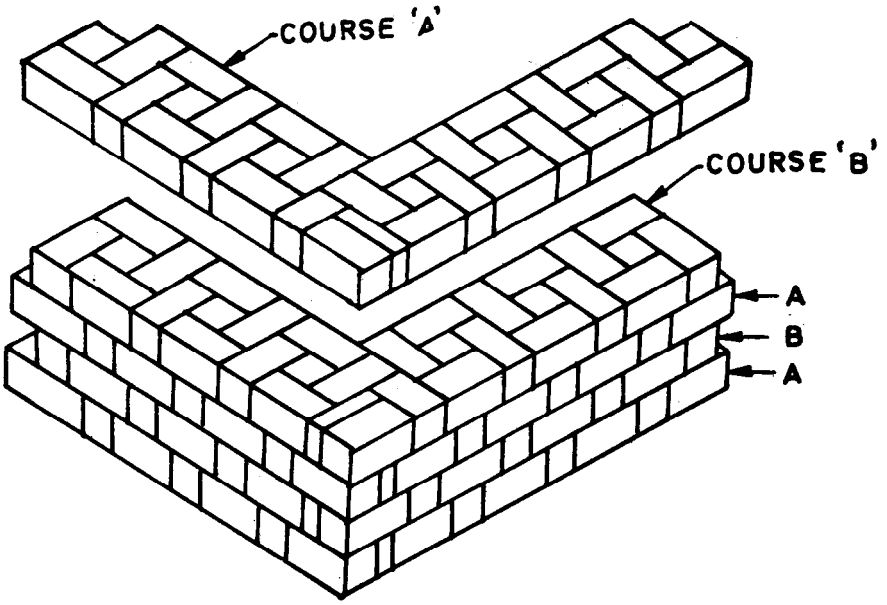


FIG. 3 DOUBLE FLEMISH BOND

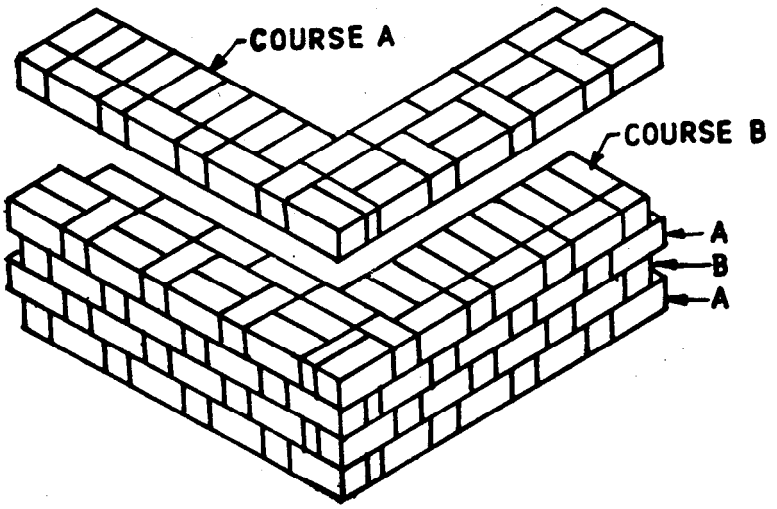


FIG. 4 SINGLE FLEMISH BOND

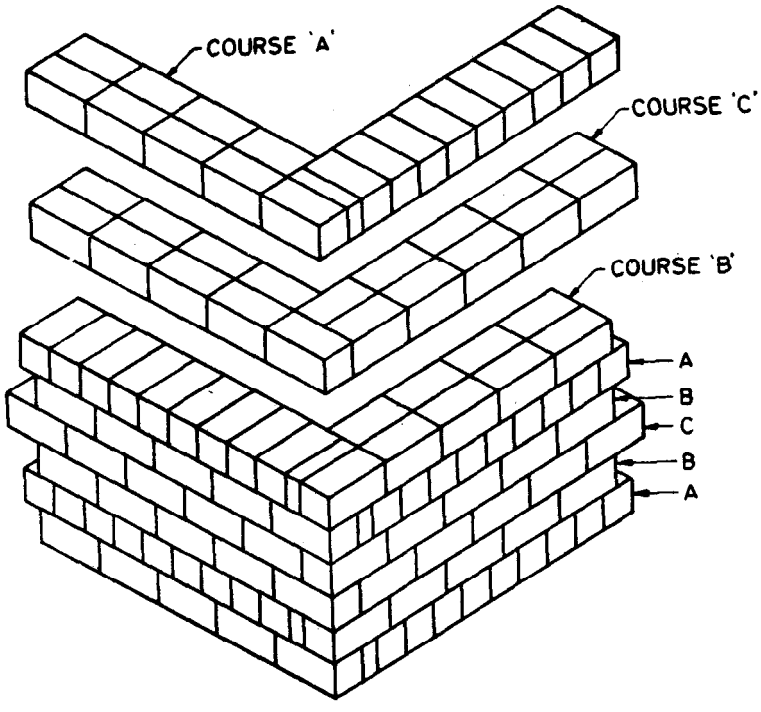


FIG. 5 ENGLISH GARDEN WALL BOND

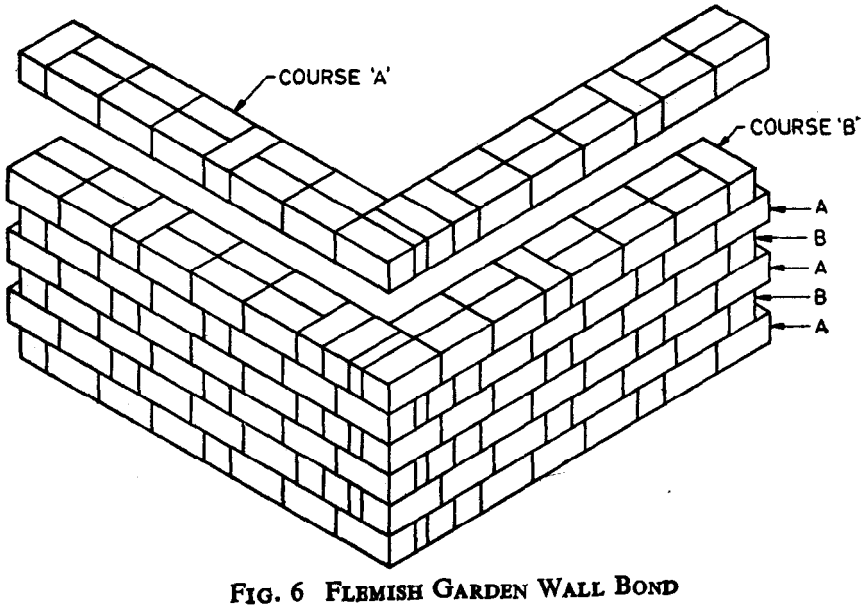


FIG. 6 FLEMISH GARDEN WALL BOND

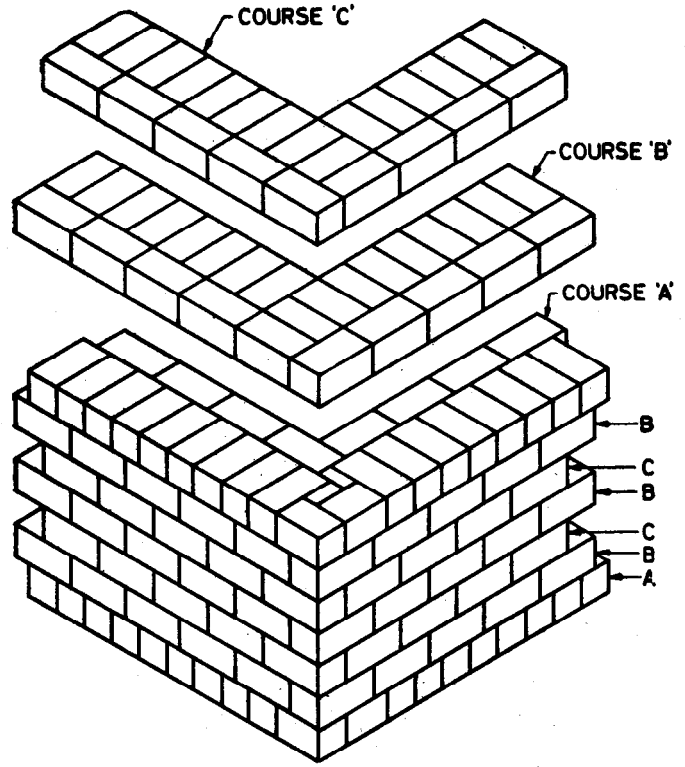
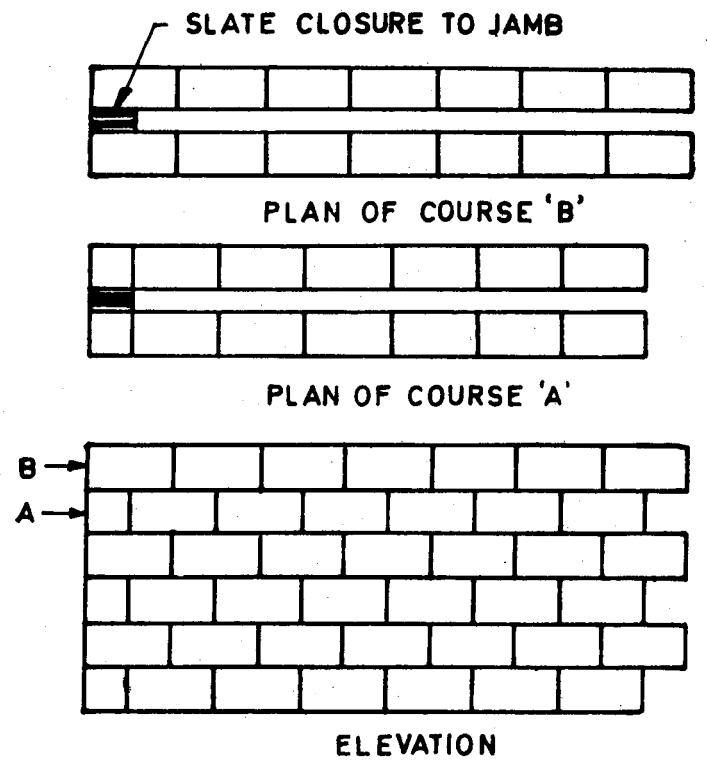


FIG. 7 AMERICAN BOND



NOTE — Use of Stretcher bond in cavity wall construction is illustrated here.

FIG. 8 STRETCHER BOND

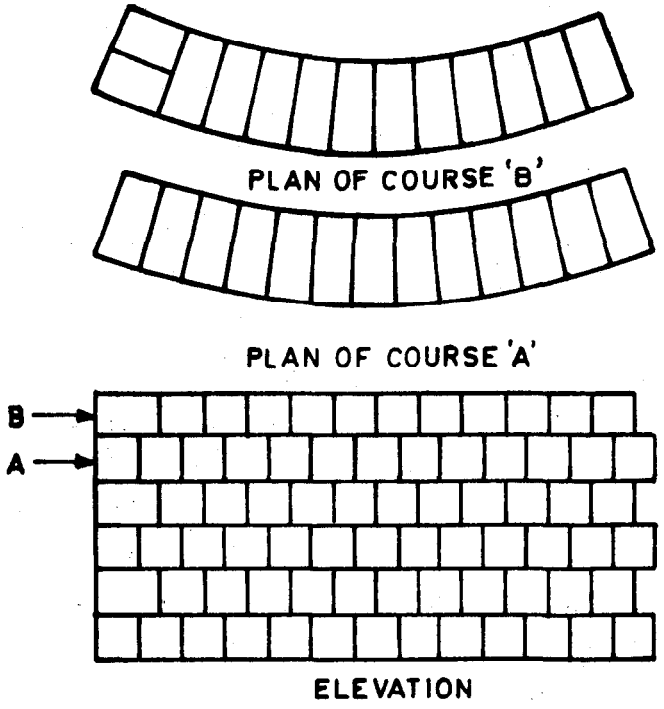


FIG. 9 HEADER BOND

6.5.2 In jointing, either the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brickwork, or the joints shall be squarely raked out to a depth of 10 mm while the mortar is still green for subsequent plastering. The faces of brickwork shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raishing the brickwork.

6.5.3 In pointing, the joints shall be squarely raked out to a depth of 15 mm while the mortar is still green and the raked joints shall be well brushed to remove dust and loose particle and well wetted, and shall be later completely refilled with mortar to give the required finish. Some such finishes are 'flush', 'weathered', 'tucked', 'ruled', etc (*see* Fig. 10).

NOTE — Pointing will offer facilities for introducing in the face joints a mortar specially prepared with regard to composition, colour, etc.

6.6 Structural and Functional Characteristics of Brickwork

6.6.1 *Structural Stability and Strength*

Reference may be made to IS 1904 : 1986 and IS 1905 : 1987 for design with regard to structural stability.

6.6.2 *Resistance to Moisture Penetration*

6.6.2.1 Rain water penetrates solid brickwork either through cracks or through the body of the bricks or mortar. Unrendred walls permit more

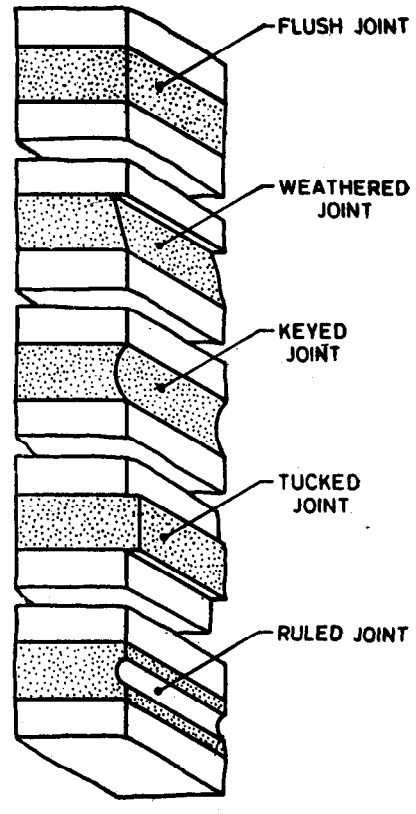


FIG. 10 DIFFERENT TYPES OF POINTING FINISHES FOR BRICKWORK

water to pass through than rendered walls, and therefore shall not be relied on to give protection from rain except under sheltered or moderate conditions.

6.6.2.2 Resistance to rain penetration will be incrased by rendering which prevents the access of water through the joints of brickwork except in small quantities passed through by capillary action. Rendered walls are, therefore, suitable for severe conditions provided other requirements, such as sufficient thickness, use of satisfactory materials, and workmanship are also satisfied.

6.6.2.3 A cavity wall will provide a perfect barrier to rain penetration. Even when the outer part of the wall gets wet, the inner one will remain absolutely dry.

6.6.2.4 Table 3 indicates the suitability of various walls under different conditions of exposure.

Table 3 Suitability of Walls for Various Exposures

(*Clause* 6.6.2.4)

R = Recommended
N = Not Recommended

Sl No.	Construction	Exposure		
		Sheltered	Moderate	Severe
(1)	(2)	(3)	(4)	(5)
1.	Unrendred ½-brick thick wall	N	N	N
2.	Unrendred 1-brick thick solid wall	R	N	N
3.	Unrendered 1½-brick thick solid wall	R	R	N
4.	Rendered solid wall	R	R	N
5.	Cavity wall or rendered one-brick thick solid wall	R	R	R

NOTE — Exposure conditions to wind and rain may be broadly divided into sheltered, moderate and severe locations.

Sheltered Conditions are, for example, regions of low rainfall (below 750 mm per annum) and where brickwork is protected by the proximity of buildings of similar or greater heights. Brickwork in the lower two storeys of buildings of such locations will fall in this group.

Moderate Conditions are obtained where the exposure is neither sheltered nor severe.

Severe Conditions are obtained where the brickwork is exposed to a moderate gale accompanied by a persistent rain. Brickwork that projects well above the surrounding buildings will, especially, be severely exposed.

6.6.3 *Thermal Stresses*

The coefficients linear expansion of bricks vary from 5×10^{-6} to 11×10^{-6} per degree Centigrade. Variations of temperature tend to produce linear changes in walls which, when restrained, may lead to internal stress resulting in cracks especially when the walls exceed 30 m (100 feet). The effects of these stresses shall be taken into consideration for a proper design.

6.6.4 *Control of Shrinkage Cracking*

6.6.4.1 When bricks having a drying shrinkage of not more than 0·02 percent are used, fine hair cracks appear in the joints. These may usually be ignored. With bricks of higher shrinkage values, major cracks may appear through the brickwork. To confine cracks to the joints and to dissipate these into a large number of fine joints, it is desirable that the mortar used shall be weaker than the bricks.

6.6.4.2 Cracking due to shrinkage normally will occur at openings or other points where the vertical or horizontal section of a wall changes. A long wall with a few openings will tend to show wider cracks above and below the openings than a similar wall with many openings. Metal reinforcement may be embedded in brickwork at points where cracking is likely to occur.

6.6.5 *Thermal Insulation*

6.6.5.1 For requirements of thermal insulation in walls, reference may be made to IS 3792 : 1978.

The thermal transmittance (U-value) of 1-brick (200 mm) thick wall with 15 mm plaster on both sides will be about 19 5 K cal/m²hdeg C (or 0·4 Btu/ft²hdeg F).

6.6.6 *Fire Resistance*

For requirements regarding resistance to fire, reference may be made to IS 1642 : 1988.

6.6.7 *Sound Insulation*

Requirements for insulation against air-borne sound are laid down in IS 1950 : 1962 and reference may be made to that standard in this connection.

6.6.8 *Durability*

Deterioration of brickwork arises due to following causes:

a) Disintegration due to soluble salts present in the brickwork or when the brickwork is in contact with subsoil water containing soluble salts (*see* Note 1);

b) Disintegration due to impurities present in the bricks which, under certain conditions are liable to disrupt the brickwork (*see* Note 2);

c) Disintegration due to frost action (*see* Note 3); and

d) Corrosion of iron or steel in reinforced brickwork.

NOTES

1 When a wall is subjected to continued wetting or alternate drying and wetting, the soluble salts therein, mostly sulphates of alkalis present in the bricks get dissolved and interact with certain components of cement or hydraulic lime in the mortar and rendering, resulting in the formation of new compounds with increased volume and consequent cracks in the bricks or in the mortar. Under similar circumstances disintegration also occurs due to the crystallization of certain salts like magnesium sulphate just inside the surface pores of the bricks giving rise to severe surface decay.

2 Nodules of quick lime in the bricks when they get hydrated due to soaking in water during construction or subsequent dampness expand in volume setting up disruptive effect on the bricks.

3 When the brickwork is saturated with water and exposed to freezing conditions, the expansion of water following the freezing has a disruptive effect on the bricks.

6.7 Footings

For construction of foundation footings in brickwork reference may be made to IS 1080 : 1985.

6.8 Damp-Proof Courses

6.8.1 The function of a damp-proof course is to prevent the passage of water from an external source into a structure or from one part of a structure to another. Damp-proof courses may consist of flexible material like tar or bitumen felts, or of a layer of dense concrete or slates or *cuddappah* stone slabs.

6.8.1.1 Damp-proofing with a layer of concrete shall conform to the following requirements:

a) Size of stone aggregate to be used	10 mm nominal size (*see* IS 383 : 1970)
b) Mix of concrete	1 : 2 : 4
c) Thickness of concrete layer	Not less than 4 cm
d) The concrete layer shall be provided with a waterproofing treatment which may be either a surface treatment or with integral waterproofing compounds	

NOTE — For surface treatment of concrete damp-proof course, it is found by experience that painting with hot bitumen at the rate of 1·7 kg/100 m^2 is satisfactory.

6.8.1.2 Slates and *cuddappah* stone slabs used for damp-proofing shall be not less than 40 mm thick.

6.8.1.3 The damp-proof course shall occupy the full width of the wall just below it, and shall be provided even under door openings.

6.8.2 Damp-proof course may be horizontal or vertical and will be required at one or all of the locations as below:

a) Below the lowest floor level to prevent entry of water from the soil;

b) Above ground level to prevent water from rising up the wall; and

c) At openings, parapets, etc, to prevent access of rain-water into the structure.

6.8.3 Where the lowest floor of a structure is below the finished ground level, a horizontal damp-proof course through the body of the wall, below the level of the underside of the floor will be required. This will have to be connected in the external walls through a vertical damp-proof course to the horizontal damp-proof course above ground level. This, in effect, seals the basement from ingress of water.

6.8.4 All walls in a building shall be provided with a damp-proof course which is at least 15 cm above the finished ground or plinth protection level and preferably immediately below the underside of the ground floor. The damp-proof course shall run without a break throughout the length of the wall, even under door or other openings.

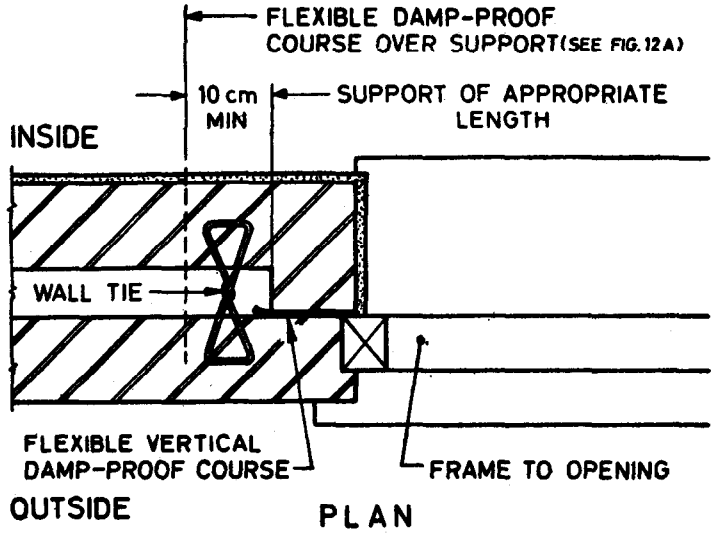
6.8.5 Damp-proof courses shall be provided on the jambs and at the top of openings where such openings occur in cavity walls. The damp-proof course in the jambs shall be vertical and shall be provided at the junction of the internal and external parts of the cavity wall so as to prevent ingress of dampness from the external part of the wall to the internal leaf (*see* Fig. 11). A flexible damp-proof course (*see* Fig. 12) shall be provided at the top to protect the lintel head from the water which flows down through the cavity above and to drain it off outside through weep holes.

6.8.6 In parapets, where the coping is of an impervious material like stone or dense concrete, no damp-proof course may be necessary across the wall. Where the coping is of a previous nature, it may be necessary to interpose a flexible damp-proof course about 15 to 20 cm above the finished roof level and carry it down the inside face of the wall to the lower face of the drip course. Damp-proofing of parapets in the case of cavity walls construction is illustrated in Fig. 13.

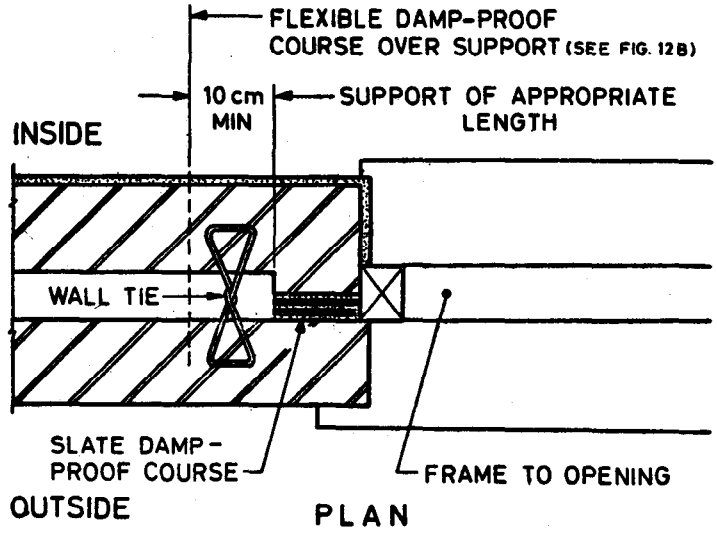
6.8.7 Damp-proofing details under architectural features is illustrated in Fig. 14.

6.9 Cavity Wall

6.9.1 The outer and inner leaves of a cavity wall may be of the same material or of different materials, such as brickwork and concrete, etc. The



11A Details with Frame for Opening on Outside



11B Details with Frame for Opening on Inside

FIG. 11 DETAILS OF DAMP-PROOF COURSES AT JAMB FOR OPENINGS IN CAVITY WALL

thicker leaf shall be arranged on the inside and the cavity or space between the two leaves of the wall shall be between 4 cm to 8 cm.

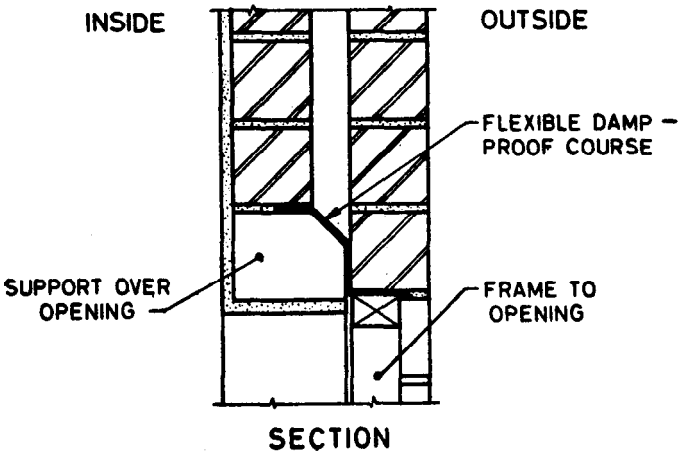
6.9.2 The function of the wall ties is to bind together the outer and inner leaves of a cavity wall. This shall be spaced not more than four brick-lengths apart horizontally and not more than 5 brick-heights vertically, and staggered. Additional ties shall be used near openings. There shall, at least, be 5 ties per square metre surface area of the wall.

6.9.3 Ties may be of mild steel, flat iron or round bars, suitably twisted at their mid-point or sloped towards the exterior side so as to prevent water from flowing along it from outer to inner leaf. Ties shall be given a bituminous or other coat before insertion to protect them from corrosion.

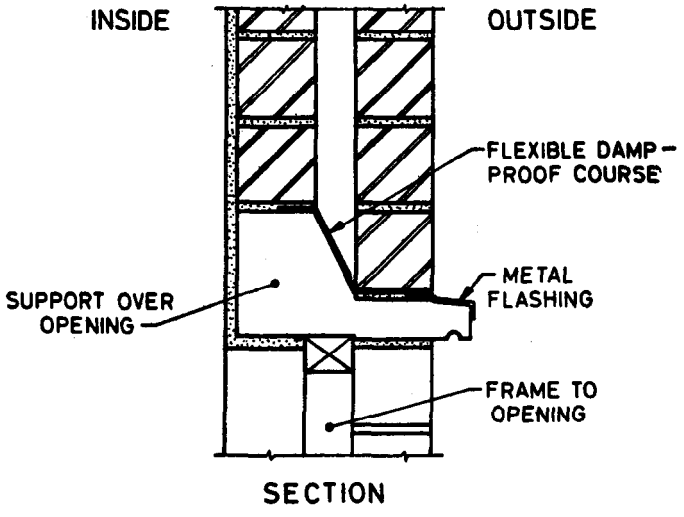
6.10 Bearing of Floors and Roofs

6.10.1 *Timber Floor and Roofs*

It is not desirable to embed any structural timber in brickwork as it is liable to be affected by dry rot. Timber wall plates shall be protected with preservative if they have to be embedded in wall. The ends of timbers joists shall preferably rest on corbels or brackets but when built into a wall they shall be treated with preservative, and in addition, space shall be left around them for free circulation of air. The ends of beams carrying heavy loads, and of trusses shall be supported on templates of concrete or stone to distribute the load over a greater area of brick wall.

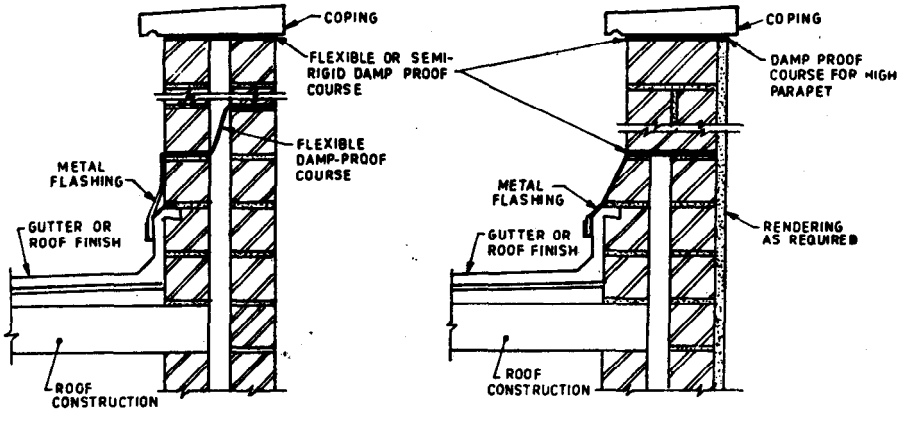


12A Head of Opening with Frame on Outside



12B Head of Opening with Frame on Inside

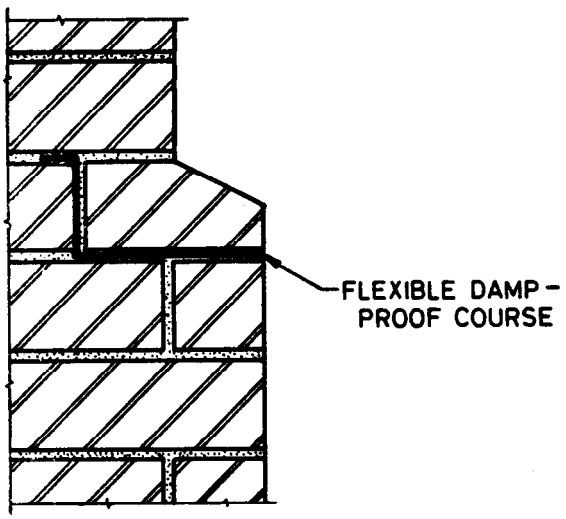
FIG. 12 DETAILS OF DAMP-PROOFING AT LINTEL HEAD LEVEL FOR OPENINGS IN CAVITY WALLS



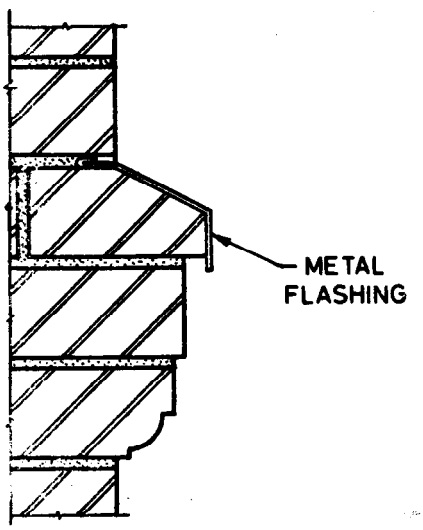
13A Details where Parapet is also of Cavity Construction

13B Details where Parapet is of Solid Construction

FIG. 13 DETAILS OF DAMP-PROOFING IN PARAPET OVER CAVITY CONSTRUCTION



14A Plinth — Solid Wall



14B String Course — Solid or Cavity Wall

FIG. 14 DETAILS OF DAMP-PROOFING IN ARCHITECTURAL PROJECTION

6.10.2 *Steel Beams*

The ends of steel beams embedded in masonry shall be built-in with space all round for repainting or shall be protected with a thick bituminous coat or shall be encased in rich concrete of mix 1 : 2 : 4. The ends shall generally be supported on templates of plain or reinforced cement concrete of mix 1 : 2 : 4, or stone.

6.10.3 *RCC Floors and Roofs*

6.10.3.1 Reinforced cement concrete floor and roof slabs resting on the wall shall have a width of bearing not less than the effective depth of slab subject to a minimum of 10 cm.

6.10.3.2 Where the bottom of the slab does not coincide with the level of a brick course, the level shall not be made up with cut bricks but the thickness of the slab at bearing shall be increased so that the bearing is directly on the brick course immediately below its level.

6.10.3.3 Ends of RCC beams shall generally be placed on template of plain or reinforced cement concrete or stone.

6.10.3.4 The ends of RCC slabs may bear on a layer of cement mortar (1 : 4 mix) 12 to 20 mm thick. Its top surface shall be white-washed or otherwise suitably treated so as to minimize the friction to movement of the concrete slab over the bearing.

6.11 Brickwork Round Openings

6.11.1 Openings shall be of such a size and so spaced in walls as to reduce cutting of bricks to the minimum. The width of openings shall, as far as possible, be a multiple of the width of a brick.

6.11.2 In external walls, it is desirable to rebate the sills, jambs and heads of openings so as to form a barrier for rain-water. The still shall be sloped slightly so as to allow rain-water to drain off.

6.12 Parapets and Copings

6.12.1 The thickness of parapets shall be such that their base covers the junction of roof slab and wall which shall be further effectively treated against possible leakage of rain-water as per IS 2115 : 1980.

6.12.2 Copings may be of stone, concrete, brick or terracotta and throated on the underside of the projection. The top of the coping shall be slightly sloped so as to allow rain-water to drain off (*see* **6.8.6** and Fig. 13).

6.13 Architectural Features

6.13.1 All projecting architectural features, such as plinth projections, string courses or cornices, shall be effectively bonded by tailing into the brickwork to ensure stability. Such architectural features shall be set straight and true with the finished joints as far as possible.

6.13.2 When such features are not to be plastered over, they shall be built with brick which have high durability, resistance to abrasion and moisture penetration. Bricks specially made to required shape for this purpose shall be used, if possible otherwise, selected bricks rubbed and ground to correct shape and size may be used.

6.13.3 Sun shades and such projecting features which depend on the men of brick masonry over them for their stability shall be kept supported till such time the brick masonry above is built and hardened sufficiently.

7 STORAGE AND HANDLING OF MATERIALS

7.1 Bricks

Bricks shall not be dumped at side. They shall be stacked in regular tiers even as they are unloaded, to minimise breakages and defacement of bricks. The supply of bricks shall be so arranged that, as far as possible, at least two days' requirements of bricks are available at site at any time.

Bricks selected for different situations of use in the work shall be stacked separately.

7.2 Cement

Cement shall be stored above ground level in perfectly dry and watertight sheds. Cement shall be stacked not more than eight bags high. The bags shall be stacked in a manner to facilitate removal and use in the order in which they are received.

7.3 Lime

Quick lime shall, as far as possible, be slaked soon after it is received. Storage of unslaked fat or semi-hydraulic lime is not desirable as the lime deteriorates by absorption of moisture from the atmosphere and also is likely to cause fires.

Slaked hydraulic lime shall be stored in the same way as cement as it sets quickly under damp conditions.

7.4 Mortars

7.4.1 The problem of storage of mortar does not arise in the case of cement and cement-lime mortar or lime mortars with hydrulic limes, as these have to be used immediately. Lime mortars using semi-hydraulic limes which sometimes require to be used after a day or two after their grinding, shall be prevented from drying out by protective covering and by occasional sprinkling of water.

7.4.2 Mortars shall be well mixed and shall be transported from the mixing platform to the site of work in such a manner as to prevent formation of laitance or segregation.

8 SETTING OUT

8.1 Generally the site shall be cleared of grass roots, tree stumps, etc, before the building lines are set out. In case of sloping terrain care shall be taken to ensure that the dimensions on plan are set out correctly in one or more horizontal planes.

8.2 The building lines shall be set out with steel tapes. Setting out of angles shall be with theodolite in case of important and intricate structures where the lengths of arms exceed 16 m. In other cases they may be set out by measurement of sides In rectangular or square setting out, diagonals shall be checked to ensure accuracy.

8.3 The setting out of walls shall be facilitated by permanent rows of pillars, parallel to and at a fixed distance beyond the periphery of the building. The pillar shall be located at the junctions of cross walls with the periphery of the building. The pillars shall be located at the junctions of cross walls with the peripheral lines of pillars. The centre lines of the cross walls shall be extended to and permanently erected on the plastered tops of the corresponding sets of pillars. The *datum* lines parallel to and at the known fixed distance from the centre lines of the external walls, shall also be permanently marked on the corresponding rows of pillars to serve as checks on the accuracy of the work as it proceeds. The tops of these pillars shall be at the same level and preferably at the plinth or floor level. The pillars shall be of size not less than 30 cm square and shall be bedded sufficiently deep into ground so that they are not easily disturbed.

8.4 Site Bench Marks

Before commencing building operation, permanent bench marks located at convenient points on the site and preferable linked with G. T. S. Bench Marks, shall be put up so as to facilitate accurate setting out of height from a fixed *datum*.

8.5 The judicious use of storey rods may ensure accuracy in setting out and facility for checking the work as it proceeds.

9 SCAFFOLDING

9.1 Single scaffolding shall not be used on important works, since subsequent filling up of the putlog holes and rendering of their surface would give an unsightly appearance. Another disadvantage with single scaffolding is that workmen are apt to support them on window and similar openings, thereby spoiling the frames and shutters.

9.1.1 Where single scaffolding is adopted, the placing of the poles, which are to rest on the brickwork under construction, shall be so adjusted as to affect only one of the headers at the point of support in the various courses.

9.2 Scaffolding shall be designed to withstand all the dead, live and impact loads which are likely to come on them. They shall also be so designed as to ensure the safety of the workmen using them and shall conform in all respects to the requirements of the relevant building regulations on safety, health and welfare and also the local building bye-laws.

10 SOAKING OF BRICKS

10.1 Bricks shall be soaked in water before use for a period that is sufficient for the water to just

penetrate the whole depth of the bricks (*see* Notes). Wetting the bricks assists in removing the the dirt, sand and dust from them. Further, it prevents the suction of water from the wet mortar, as otherwise the mortar is likely to dry out soon and crumble before attaining any strength. The bricks shall not be too wet at the time of use, as they are likely to slip on the mortar bed and there will be difficulty in ensuring plumbness of the wall. Moreover, proper adhesion of bricks to mortar will not be possible if the bricks are too wet.

NOTES

1 The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in the construction work.

2 If the bricks are soaked for the required time in water that is frequently changed, the soluble salts in the brick will be leached out, and subsequent efflorescence will be reduced.

10.2 When bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place, where they are not again spoiled by dirt, earth, etc.

11 LAYING OF BRICKWORK

11.1 General

11.1.1 Brick shall be laid on a full bed of mortar. When laying, the bricks shall be slightly pressed so that the mortar gets into all the pores of the brick surface to ensure proper adhesion. Cross joints and wall joints shall be properly flushed and packed with mortar so that no hollow spaces are left. Properly filled joints ensure maximum strength and resistance to penetration of moisture which takes place mainly through joints.

In the case of thick walls (two-brick thick and over), the joints shall be grouted at every course in addition to bedding and flushing with mortar.

The course at the top of the plinth and sills at the top of the wall just below the roof slab or floor slab and at the top of the parapet, shall be laid with bricks on edge (applicable only in the case of traditional bricks); and at corners and deadends the bricks shall be properly radiated and keyed into position by using cut-bricks (also known as *'punja'* bricks or *'maruconas'*). Typical shape and arrangement of these bricks are shown in Fig. 15.

11.1.2 Bricks with 20 mm deep frog shall be used frog-down. Bricks with 10 mm deep frog shall be used either frog-up or frog-down.

11.1.3 The courses shall be aligned and care shall be taken to keep the perpends.

11.1.4 The brickwork shall be built in uniform layers; corners and other advanced work shall be racked back. No part of a wall during its construction shall rise more than one metre above the general construction level, to avoid unequal settlement and also improper jointing.

11.1.5 The face joints shall be finished either by jointing or by pointing as specified, in accordance with **6.5**.

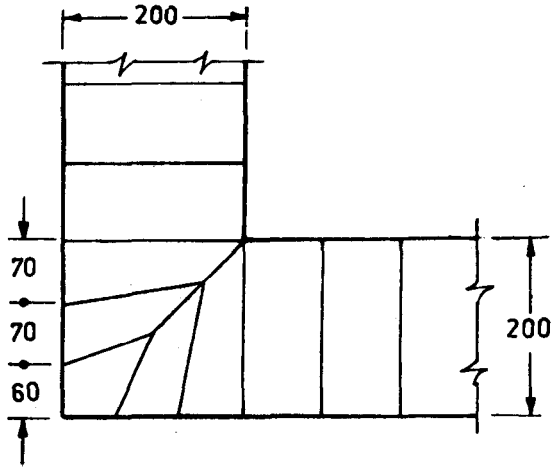


FIG. 15 A TYPICAL ARRANGEMENT OF CUT-BRICKS IN A CORNER

11.1.6 Toothing may be done where future extention is contemplated but shall not be used as an alternative to racking back.

11.2 Walls

11.2.1 All quoins shall be accurately constructed and the height of the courses checked with storey rods as the work proceeds. In general, quoin-bricks shall be headers and stretchers in alternate courses, the bond being established by placing a quoin closer next to the queen header.

11.2.2 Acute and obtuse quoins shall be bonded, where practicable, in the same way as square quoins. Obtuse quoins shall be formed with squints showing a three-quarter brick on one face and a quarter brick on the other.

11.3 Plasters

These shall be set out as to avoid broken bond.

11.4 Openings

11.4.1 The depth of reveals and rebates shall, where practicable, conform to standard brick sizes in order to avoid cutting of bricks and thereby weakening the work.

11.4.2 The arrangement of bond at quoins at jambs of openings shall be symmetrical.

11.5 Partitions

For half-brick partitions to be keyed into main walls, indents shall be left in the latter.

11.6 Arches

Arches shall be turned with ordinary bricks over timber centres, generally in rings of half-brick length. For face work, the bricks shall be either specially manufactured bricks or ordinary bricks cut and rubbed to shape in order to obtain uniform radial joints.

11.6.1 Flat arches may be used for the sake of appearance, but for purposes of carrying loads of the wall above they shall be used in conjunction with relieving arches, or with lintels placed behind.

11.6.2 In the construction of a flat arch, though the extrados is perfectly level, the intrados is given a slight camber to allow for any slight settlement or to correct the apparent sagging of a horizontal line, the usual allowance being about 1 mm rise at the centre for every 100 mm of span.

11.6.3 Large arches in masonry shall be constructed in accordance with IS 2118 : 1980.

11.7 Fixing of Frames

11.7.1 Where door or window frames of timber are fixed in the openings, the fixing shall be done generally with hold-fasts of adequate size and strength securely embedded in the brickwork or in chases later filled up by cement mortar or concrete. Hold-fasts shall be fixed in the brickwork for a sufficient length and then turned up at end into a cross joint, thus avoiding indiscriminate cutting of bricks Iron hold-fasts shall be given a protective coat of bitumen to avoid rusting. Woodwork faces in contact with brickwork shall be treated with wood preservative to prevent attack from insects and termites.

11.7.2 Fixing of steel doors and windows shall be done in accordance with IS 1081 : 1960.

11.7.3 Fixing of timber doors and windows shall be done in accordance with IS 4913 : 1968.

11.7.4 The frames shall preferably be fixed simultaneously as the masonry work proceeds, as this construction will ensure proper bond without gaps between the masonry and the frames.

11.8 Reinforced Brickwork

11.8.1 Reinforcement in half-brick partition walls may be in the form of mild steel flats or hoop iron, expanded mesh, or mild steel bars or fabric. These are generally used in every third or fourth courses of the brickwork They shall be securely anchored at their ends where the partitions bond.

11.8.2 In the cast of round bars used as reinforcement, the diameter shall not exceed 8 mm. Flat bars and similar reinforcement shall not have a thickness exceeding 8 mm.

11.8.3 The thickness of reinforced brick wall shall be not less than 100 mm.

11.8.4 The crushing strength of the bricks used in reinforced brick masonry shall be not less than 7·5 N/mm^2.

11.8.5 The mortar used for reinforced brickwork shall generally be rich, dense, cement mortar of mix about 1 : 4. Lime mortars shall not be used.

11.8.6 The inlaid steel reinforcement shall be completely embedded in mortar. Overlaps in the reinforcement, if any, shall not be less than 300 mm.

11.8.6.1 The mortar covering in the direction of joints shall be not less than 15 mm.

11.8.6.2 The mortar interposed between the reinforcement bars and the brick shall be not less than 5 mm thick.

11.8.7 In the case where the reinforcements cross inside a joint, the diameter of the reinforcement shall not exceed 5 mm, unless specially shaped bricks are used to permit larger reinforcement.

11.9 Protection Against Damage

11.9.1 Care shall be taken during construction that edges of jambs, sills, heads, etc, are not damaged.

11.9.2 In inclement weather, newly built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away.

11.10 Curing

In hot and dry weather, the mortar is likely to dry up before it has attained its final set and may crumble. This shall be prevented by keeping the brickwork constantly wet for at least seven days, except in the case of brickwork with mud mortar for which no such curing is required.

11.11 Provision for Service Installations

To facilitate taking service lines later without inordinate cutting of completed work, sleeves and chases shall be provided during the construction itself. Such sleeves shall slope down outwards in external walls so that their surface cannot form channels for the easy passage of water inside.

11.12 Cavity Walls

11.12.1 As the main object of providing a continuous cavity in an external wall is to prevent rain penetrating to the inner face, care shall be

exercised during construction that the cavity is continuous and free from obstruction. As far as possible, mortar droppings shall be prevented from falling down the cavity by the use of laths or by haybands which shall be drawn up the cavity as the work proceeds. Any mortar which may unavoidably fall on the wall-ties be removed daily and temporary openings shall be provided to permit the daily removal of mortar droppings from the bottom of the cavity.

11.12.2 Special precautions as laid down in IS 1649 : 1962 shall be taken in building flues adjacent to cavities.

11.12.3 *Bond*

In building hollow walls of half-brick thickness, only stretcher bond shall be used, unless purpose-made snap headers are available. When header bricks are cut and used, they are either likely to protrude into the cavity and form ledges for mortar droppings to collect or they may be so short as to weaken the structure.

11.12.4 The outer and inner leaves shall be tied by means of wall ties. The wall ties shall preferably be bedded with a slight fall towards the exterior part of the wall.

11.12.5 At the base of the cavity wall, the foundations and basement shall be solidly constructed up to 300 mm above the ground level. The air cavity shall begin not less than 200 mm below the upper floor surface of the ground floor and the cavity shall be continued without interruption up to the roof.

11.12.6 *Ventilation*

In order to keep the cavity dry, air slots shall be provided above the ground floor level and below the eave level of the roof to extent of 500 mm^2 area of vents to every 20 m^2 area of the wall.

11.12.7 The following precautions shall be observed at the top of the cavity:

a) *Parapets* — If the top of a hollow wall ends with a parapet, the cavity shall be carried up to the full height of the wall or stopped at the roof-flashing level.

b) *Eaves* — If a roof projects over the top of the wall, the cavity shall be closed at the top.

c) *Party Walls* — In a hollow party wall, the top of a cavity shall be closed just above the uppermost ceiling level and the courses over shall be continued in solid brickwork. A sound-insulating material shall be interposed between the hollow wall and the solid brickwork.

11.12.8 At the points where the two leaves of the hollow wall come into contact (for example, at windows and doors), they shall be separated by a water-tight membrane.

11.12.8.1 Above the lintels of doors and windows, damp-proof membrane shall be inserted slopping downwards and outwards.

11.12.8.2 At solid jambs a vertical damp-proof course shall be inserted between the outer and inner parts of the wall.

12 INSPECTION

12.1 General

The object of inspection of brick masonry work is to ensure its satisfactory performance and also to ascertain whether all the recommended practice of workmanship is adopted at every stage. As the correct strength of masonry cannot be ascertained without destruction, a close supervision during the course of construction is necessary to ensure satisfactory performance. The strength of brickwork depends on the strength of individual brick, strength of mortar, bond and workmanship.

12.2 Inspection of Materials

In case of large works, samples of bricks, sands, *surkhi*, lime, cement, etc, which go to form the brickwork, shall be periodically tested in a laboratory to make sure that they conform to the requirements stated in 5. Simple field tests may suffice in the case of small works.

12.3 Inspection of Workmanship

A close supervision while the work is in progress will ensure a better quality work with the materials available for use. The following shall be observed at the time of inspection:

a) All loose materials, dirt and set lumps of mortar which may be lying over the surface over which brickwork is to be freshly started, shall be removed with a wire brush.

b) All the bricks shall be thoroughly soaked in clean water immediately before use.

c) The surface over which the brickwork is to be started shall be slightly wetted.

d) The first course itself shall be made horizontal by providing enough mortar in the bed joint to fill up any undulations in the bed course.

e) Plastic mortar results in thorough bedding of the brick and more complete filling of the joints which ensure greater strength. Care shall be taken to see that the required quantity of water is added to the mortar at the mixing platform itself and not over the courses.

f) All the joints shall, as far as possible, be thin and the specifications mentioned in **6.4** in this regard shall be strictly adhered to.

g) Care shall be taken to see that there is no through joints and the lap is not less than half the width of the brick, and that all the vertical joints are properly filled with mortar.

h) The verticality of the walls and horizontality of the courses shall be checked very often with plumb bob and spirit level respectively.

j) No portion of the work shall be left more than 1 m lower than the other. Where the masonry of one part has to be delayed the work shall be 'raked back' suitably at an angle not exceeding 45° according to bond and not toothed.

k) Where plastering is required to be done all the vertical as well as horizontal joints shall be raked to a depth of about 10 mm while the mortar is wet, and this will ensure satisfactory adhesion between the plaster and brickwork, and

m) Care shall be taken to ensure that the brick work is kept wet for seven days commencing from 24 hours after the course is laid.

13 MAINTENANCE

13.1 Where proper materials and workmanship are used, brickwork will need little maintenance. If, however, defects occur, they may be due to the following causes:

a) Sulphate attack on mortars and renderings,

b) Use of unsound materials,

c) Corrosion of embedded iron or steel,

d) Crystallization of salts from the bricks, and

e) Defects due to shrinkage on drying.

13.2 Sulphate Attack on Mortar and Rendering

13.2.1 Sulphates present in brickwork react in the presence of water with alumina contents of the cement and hydraulic limes in the mortar and rendering, forming other salts with considerable increase in volume, and consequently chip and spall the bricks, produce cracks in the joints and renderings, and disintegrate the mortar. Water is, therefore, essential for this defect, and it may arise in exposed situations in brickwork. Parapets, boundary walls, chimney walls, etc, shall be built with bricks of low sulphate content. Similarly, brickwork in situations where wet conditions are to be expected, such as below damp-proof course, in manholes, in retaining walls, etc, shall also be built of bricks with low sulphate content. Brickwork exposed to sea spray shall be made with dense bricks and cement mortar. Brickwork in exposed situations shall not be given a rich cement rendering (say richer than 1 : 4 cement : sand mix) as the latter, due to shrinkage cracks, may admit penetration of water into the body of the wall, and at the same time, prevent its ready evaporation due to its close texture.

13.2.2 Sulphate attacks in their initial stages may be remedied by rectifying the possible sources of water seepage into the body of brickwork and by scraping the affected mortar and rejointing and rendering. In more advanced stages, the only remedy is to pull down the affected parts and reconstruct them.

13.2.3 The primary precaution to be taken to prevent sulphate attacks is to adopt constructional details and choose materials that will ensure complete preventation of entry of water into the brickwork.

Some important constructional details to avoid wet conditions are stated below:

a) Damp-proof courses shall be provided under all jointed members covering the horizontal or sloping faces of brickwork including copings, sills, chimney caps.

b) All projecting features formed with joined units, such a cornices and string courses, shall be covered with properly designed flashings, and where necessary, cover flashings shall be provided at the wall face. Cement fillets and cement renderings used as a protection to horizontal surfaces are unlikely to be satisfactory; both are liable to develop shrinkage cracks which let in water.

c) Parapet walls shall not be sealed on both faces by impervious rendering; this reduces the rate of evaporation and may ultimately result in a wet-condition of the brickwork.

d) On walls faced with external renderings, all damp-proof courses shall extend through the facing and turn down to form protectective drips.

e) Where flashings are used above roof level in conjunction with damp-proof courses, they shall be inserted immediately below the damp-proof courses.

f) Cavity walls shall be effectively drained by weep holes above all damp-proof courses that bridge the cavity.

g) The use of dense stones or bricks as a facing to porous brickwork in solid walls may lead to prolonged dampness of the wall. Water entering through the shrinkage cracks may

not evaporate sufficiently rapidly through the dense facing.

13.3 Use of Unsound Materials

13.3.1 Bricks containing burnt noduless of quicklime, and mortar containing unslaked particles of lime are often responsible for cracks in bricks, and for pittings displacement cracks, etc, in mortars; when coming in contact with water, the quicklime gets hydrated and expands in volume and causes such defects.

13.3.2 The remedy lies in ensuring that all lime is properly slaked before mixing into mortar, and in choosing bricks burnt from the proper soil. Constructional details designed for excluding moisture from such walls (*see* **13.2**) will also stop this trouble.

13.4 Corrosion of Embedded Iron and Steel

Iron and steel corrode in contact with atmospheric moisture, where such moisture is laden with acids sulphates and chloride salts in solution. In coastal areas such corrosion occurs rapidly. Iron embedded in brickwork is corroded for the same reason when such salts are released in solution from the bricks themselves when damp. While undergoing corrosion, the iron expands considerably and tends to disrupt the brickwork. Prevention of such corrosion may be achieved by giving an encasement of 15 to 25 mm of dense cement mortar (1:4 mix or richer) around all embedded steel sections. Iron and steel members partially embedded in brickwork tend to corrode at the point of their entry into the brickwork and to prevent this, they shall be given a bituminous protective coating at that place.

13.5 Crystallisation of Salts

13.5.1 When bricks containing soluble salts are used in construction, these salts are dissolved out, if water passes into the brickwork and are deposited in the form of fine crystals on the face of the brickwork. This is known as efflorescence.

13.5.2 Efflorescence will be a common phenomenon with new construction since the water used in the construction invariably leaves the salts dissolved from the brickwork on the face. When the structure dries up, this efflorescence shall be scrubbed out dry with brushes. They shall not be washed as the solution will again be absorbed into the brickwork. Cleaning with acids shall not be done as new salts are formed thereby.

NOTE — In some cases, when the efflorescence is composed mainly of lime and the lime has had time to carbonate into almost insoluble chalk, the surface may be wetted to prevent undue absorption and then scrubbed down with a solution of one part of commercial hydrochloric (muriatic) acid in 20 parts of water and subsequently washed down to remove all traces of acid, care having been taken previously to protect any metal or other work likely to be damaged by the acid.

13.5.3 Continued efflorescence would indicate that water from leaks or similar sources is finding its way into the brickwork through previous channels. In these cases, entry of water shall be located and stopped.

13.5.4 Some of the salts, like magnesium sulphate have a disintegration effect on the brick face, and cause it to crumble to dust. Chemical analysis of the surface scrapings will indicate the nature of the salts and if they are of the harmful type special care shall be taken to seal off the entry of water into the brickwork.

13.6 Defects Due to Shrinkage or Drying

Brickwork generally swells with absorption of water and when the water evaporates, it shrinks and in so doing develops vertical cracks, and when the mortar of the brickwork is lean, the cracks are distributed over a large number of joints so that they are not significantly visible. However, when the mortar is rich, the resulting cracks are few but wider, occurring at the weakest point in the brick or mortar. These cracks have no adverse effect on the structural strength of the work and may be easily rectified. These do not recur after the first season of drying out provided the walls are generally water-tight.

14 REPAIRING BRICKWORK

14.1 Defects and cracking in brickwork may be due to one or several causes mentioned in clause **13.1** and to execute effective repairs, it is necessary to know the cause of damage. The effect of defect in a wall must be judged in relation to the building as a whole and the general soundness of its construction and the particular function of the wall is called upon to serve. The nature of repairs mainly depends on whether it is structural damage or surface cracking only. At times even wide cracks may not seriously affect the stability of the structure provided the brickwork is not distorted or is not much out of plumb.

14.2 Before deciding the course of treatment to be adopted to following factors shall be considered:

a) The type of foundation on which the wall is constructed;

b) The position and bonding of cross walls and other connecting structural members;

c) Whether the wall is true to plumb;

d) Whether floors, roofs, upper walls, etc, are liable to exert thrust or restraint to further movement; and

e) The aesthetic effect of the crack over the building as a whole.

14.3 Treatment of Structural Damage

14.3.1 Where walls become unsafe due to differential movements resulting from seasonal fluctuations in the moisture content of subsoil or due to the presence of filled materials below the foundations, the work may require special measure such as providing reinforced concrete band at plinth level, lintel level, top level, etc, and lowering ground-water table.

14.3.2 For damages other than mentioned in **14.3.1** one of the following treatments may be adopted:

a) To provide tie rods passing through the floor or at roof level anchoring the damaged wall to another wall or structural member that is sound or has tendency to move in the opposite direction.

b) To build buttresses, keyed into the damaged wall so as to give thrust against the wall in the required direction. It shall be ensured that the buttresses rest on firm soil without giving way to settlements or movements.

c) In case the wall is noticed to be out of plumb, the damaged or bulged portion of the wall shall be dismantled and rebuilt with mortar of the same proportion as the adjoining portion.

14.3.3 *Treatment of Cracks Across Walls*

14.3.3.1 These cracks are more or less diagonal cracks and either follow the vertical and horizontal joints alternately or pass straight down through alternate vertical joints and the intervening bricks and mortar beds. In these cases one of the following methods may be adopted:

a) If the cracks are of such nature that they are likely to encourage the penetration of rain if they are not repaired, it is necessary to cut out and replace the cracked bricks.

b) If the cracks are wide, the two portions can be stitched by inserting bond stone or precast reinforced concrete blocks at suitable intervals. The cracks shall then be grouted. Sufficient care has to be taken in preparing the precast concrete blocks so that the patched surface will match with the surrounding surface. In repairing cracks with mortar it is important to secure satisfactory adhesion between the masonry of the existing work and the new bricks and also not to use too strong a mortar mix Otherwise shrinkage of the new rich mortar may cause a fresh crack to develop. To promote adhesion, the brickwork shall be wetted before the mortar is filled in.

14.3.3.2 If a number of cracks have appeared in a single wall and the cracks cross each other these cracks can not be effectively repaired. The walls in such cases have no strength and it is advisable to dismantle the entire wall and reconstruct the same, supporting the structure above in a suitable manner.

In case the diagonal cracks have occurred in a localised place of the wall, the brickwork at the damaged place and around shall be dismantled and rebuilt. While dismantling such portions, care shall be taken to relieve the load on the wall by providing props at suitable places. The props or supports for the structure above the work under repair shall not be removed till the rebuilt masonry has attained enough strength.

14.3.3.3 Where the cracks are likely to continue to widen for sometime after initial development (such as in the case of cracks due to ground movement in shrinkable clay sub-soil) it would be advisable not to repair the cracks with mortar. If filling is found necessary to prevent the penetration of moisture or rain, an oil based mastic shall be applied by caulking or by a gun.

14.3.3.4 *Surface cracks*

Where the mortar in the joints has become damaged without dislocating the brickwork, which may be due to initial usage of poor mortar, improper filling or action of frost or fire or unknown elements of nature, the joints shall be raked thoroughly to a depth of at least 20 mm and the raked joints caulked with mortar and the brickwork pointed. Care shall be taken to avoid the usage of a strong mortar for caulking purposes. The patch work shall be properly cured (*see* **11.10**).

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
226 : 1975	Structural steel (standard quality) (*fifth revision*)
269 : 1976	Ordinary and low heat Portland cement (*third revision*)
383 : 1970	Coarse and fine aggregates from natural sources for concrete (*second revision*)
405 (Part 2) : 1977	Lead sheet and strip : Part II For other than chemical purposes (*second revision*)
412 : 1975	Expanded metal steel sheets for general purposes (*second revision*)
432 (Part 1) : 1982	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement : Part 1 Mild steel and medium tensile steel bars (*third revision*)
432 (Part 2) : 1982	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement : Part 2 Hard drawn steel wire (*third revision*)
455 : 1976	Portland slag cement (*third revision*)
456 : 1978	Code of practice for plain and reinforced concrete (*third revision*)
712 : 1984	Building limes (*third revision*)
1077 : 1991	Common burnt clay building bricks (*fifth revision*)
1080 : 1985	Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell) (*second revision*)
1081 : 1960	Code of practice for fixing and glazing of metal (steel and aluminium doors, windows and ventilators)
1212 : 1978	Methods for testing tar and bituminous materials : Determination of loss on heating (*first revision*)
1322 : 1982	Bitumen felts for water-proofing and damp-proofing (*third revision*)
1344 : 1981	Calcined clay pozzolana (*second revision*)
1489 : 1976	Portland-pozzolana cement (*second revision*)
1566 : 1982	Hard-drawn steel wire fabric for concrete reinforcement (*second revision*)
1580 : 1969	Bitumen compounds for water-proofing and caulking purposes (*first revision*)
1630 : 1984	Mason's tools for plaster work and pointing work (*first revision*)
1635 : 1975	Code of practice for field slaking of building lime and preparation of putty (*first revision*)
1642 : 1988	Code of practice for fire safety of buildings (general) : Materials and details of construction (*first revision*)
1649 : 1962	Code of practice design and construction of flues and chimneys for domestic heating appliances (*first revision*)
1904 : 1986	Code of practice for design and construction of foundations in soils: General requirement (*third revision*)
1905 : 1987	Code of practice for structural use of unreinforced masonry (*third revision*)
1950 : 1962	Code of practice for sound insulation of non-industrial buildings
2115 : 1980	Code of practice for flat-roof finish, mud phuska (*second revision*)
2116 : 1980	Sand for masonry mortars (*first revision*)
2118 : 1980	Code of practice for construction of jack-arch type of building floor or roof (*first revision*)
2180 : 1988	Heavy duty burnt clay building bricks (*third revision*)
2250 : 1981	Code of practice for preparation and use of masonry mortars (*first revision*)
3466 : 1988	Masonry cement (*second revision*)
3792 : 1978	Guide for heat insulation of non-industrial buildings (*first revision*)
3812 : 1981	Fly ash for use as pozzolana and admixture (*first revision*)
4098 : 1983	Lime-pozzolana mixture (*first revision*)
4913 : 1968	Code of practice for selection installation and maintenance of timber doors and windows
8041 : 1978	Rapid hardening Portland cement (*first revision*)
8043 : 1978	Hydrophobic Portland cement (*first revision*)

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This Indian Standard has been developed from Doc : No. CED 13 (4782).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at New India Printing Press, Khurja, India